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Via Electronic Filing

Monday, July 9, 2018

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth St., S.W
Washington, DC 20554

Re: **Amendment to License Modification Applications IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, and SAT-MOD-20151231-00091 (the “Modification Applications”) IB Docket No. 11-109 and 12-340**

Dear Ms. Dortch:

I, Stephen Wilkus, managing partner and chief technology officer of Spectrum Financial Partners, LLC (“Spectrum Financial”) hereby submits comments in the captioned Proceeding. I file in support of the latest amendment to the Ligado License modification applications, in particular, to the immensely reduced low frequency block emission limit of 9.8 dBW and improved monitoring, reporting and notification commitments¹. I have reviewed the analysis of the U.S. Department of Transportation of April 2018 regarding the question of how to protect certified aviation receivers and applaud Ligado’s concession to adopt its 9.8 dBW transmit power limit.²

I have followed Ligado’s efforts since the late 1980s when, as MSV and Skyterra, and later as LightSquared, it discussed plans and equipment needs with Bell Labs where I was then employed. I participated in several evaluations of LightSquared’s spectrum holdings, interference concerns, RF filter capabilities and characteristics and mitigation strategies. I was invited as a subject matter expert to participate as a panelist at several associated FCC workshops.^{3,4,5} In short, I am a recognized expert in these interference issues, their analysis and mitigation.

¹ See Letter from Gerard J. Waldron, Counsel to Ligado Networks LLC, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109 *et. al.* (May 31, 2018), available on-line and last accessed on June 26, 2018 at [https://ecfsapi.fcc.gov/file/1053120688074/Ligado%20License%20Modification%20Cover%20Letter%20and%20Amendment%20\(5-31-2018\).pdf](https://ecfsapi.fcc.gov/file/1053120688074/Ligado%20License%20Modification%20Cover%20Letter%20and%20Amendment%20(5-31-2018).pdf).

² United States Department of Transportation, “Global Positioning System (GPS) Adjacent Band Compatibility Assessment,” Final Report of April 2018 available on-line and last accessed on June 26, 2018 at: <https://www.transportation.gov/sites/dot.gov/files/docs/subdoc/186/dot-gps-adjacent-band-final-reportapril2018.pdf>. Appendices and background web site available on-line at: <https://www.transportation.gov/pnt/global-positioning-systemgps-adjacent-band-compatibility-assessment>.

³ Alcatel Lucent presentation at FCC forum on the future of wireless band plans of July 16, 2012, available at: <http://transition.fcc.gov/bureaus/oet/tac/tacdocs/meeting71612/PANEL2.2-Wilkus-Alcatel-Lucent.pdf> (last accessed June 25, 2018).

⁴ FCC Receiver Workshop of March 12, 2012 available on-line at <https://transition.fcc.gov/bureaus/oet/...workshop1/.../SESSION-3-4-Wilkus-ALU.pdf> (last accessed June 25, 2018).

⁵ FCC Learn Workshop on Incentive Auctions of May 3, 2013, agenda available on-line, last accessed June 26, 2018 <https://ecfsapi.fcc.gov/file/7022421551.pdf>

After 27 years at Bell Laboratories in AT&T and successors Lucent and Alcatel-Lucent, I left and founded Spectrum Financial Partners, LLC that has bid on and been granted 23 licenses in the 600 MHz Incentive Auction. As a paid consultant in 2015 and 2016 I analyzed some interference issues for Ligado, focusing on the mathematical analysis of the peaking limits of Rician fading statistics of the sort that air-to-ground interference experiences. I was asked by Ligado if I might weigh in on this proceeding, but this filing was not performed under contract and will result in no remuneration from Ligado. Rather, this is submitted as a civic contribution to the docket by a friend of the Commission and a proponent of the efficient use of mobile broadband spectrum and the benefit of mobile users and the national interest as I see it.

DOT Analysis and determination of the 9.8 dBW transmit power limit

The recently finalized report by the Department of Transportation (DOT) is an exhaustive study of both experimentally measured and analytically derived power limits of potential interferers such as Ligado's planned base stations.⁶ It considered both linear and non-linear (intermodulation) sources of interference and determined Interference Tolerance Masks (ITMs) through testing of some 80 GPS devices of various classes, as well as making a detailed analytical assessment of the tolerable transmit power limits for the use case of mobile base station to aeronautical devices such as helicopters that may be located at height below that of the base station, finding that to be the most restrictive scenario. The report concluded that 9.8 dBW is the lowest rare event based EIRP limit acceptable for dual polarized base station antenna at the 250 ft. assessment zone radius.

With respect to certified aviation, the DOT analysis concluded that an EIRP limit of 9.8 dBW (approximately 10 Watts) power limit for the low band (1526 to 1536 MHz) is notably lower than earlier estimates of acceptable limits. That Ligado concedes to accept this low limit is remarkable given that they had earlier applied for a 42 dBW authorized level, a decrease of 32.2 dB or a linearized factor of 1660 times lower power, just 0.060% of the power authorized in 2010. This 9.8 dBW level, for Ligado macrocells, is the power used in many small cells today.

GPSI acceptance of ground-level power levels at higher TX Powers

As mentioned in Garmin's recent filing⁷, but before Ligado's May 31st application adopting its further reduction in power, "It has been Garmin's position since mid-December 2015 that it does not object to modification applications filed by Ligado on December 31, 2015," just as with the other members of the GPS Innovation Alliance (GPSIA) (Letter of July 13, 2017) Garmin along with John Deere, Trimble and TopCon do not oppose, based upon terrestrial use of GPS, Ligado's earlier amendment request.⁸ Given that Ligado's May 31st filing acceded to the reduced power needed for aeronautical GPS systems, these GPS manufacturers' previous acceptance suggests that both terrestrial and aeronautical users are well addressed.

Regulatory Difficulties with Receivers establishing prior use rights

It is problematic; to say the least, that receive-only devices such as GPS receivers can establish prior-use rights in bands that are not allocated to their use. In other contexts, this is referred to as "squatting," and is considered akin to theft. In the present instance, the highest quality GPS receivers have long been implemented with the widest band front-end filters that inevitably have the least selectivity and are now seen as having the greatest sensitivity to interference from the changing use of nearby spectrum. This has obviously placed the FCC in the awkward position of having to essentially grant squatter's rights to tens of millions of GPS users, particularly to safety of life users with the most sensitive devices.⁹

⁶ *ibid*, §5.2.3.8 pages 148 to 149.

⁷ See *Ex Parte* letter of May 16, 2018, M. Anne Swanson for Garmin International to Ms. Dortch in IB Docket Nos. 11-109 and 12-340 available on line at https://ecfsapi.fcc.gov/file/105162544417267/Garmin_Ex%20Parte%205-16-2018.pdf (last accessed June 28, 2018).

⁸ See letter of July 26, 2017 to Ms. Dortch in IB Docket Nos. 11-109 and 12-340 by Roberson and Associates, LLC available on-line at <https://ecfsapi.fcc.gov/file/107261195924999/RAA%20Response%20to%20GPS%20Innovation%20Alliance%20Ex%20Parte.7.26.2017F.pdf> last accessed July 8, 2018.

⁹ See, e.g., Thomas Winslow Hazlett, *THE POLITICAL SPECTRUM* (Yale University Press 2017), chapter 18.

At the same time, the regulation of receive-only electronics is also anathema to the regulators and the public, except for various labeling requirements such as with part 15, for which some devices must be labeled, “This device must accept any interference received, including interference that may cause undesired operation.”¹⁰

Ligado has evidently scaled back on its operating parameters to such a degree that it has been able to return to the FCC with proposed operating parameters that reflect its agreements with GPS industry members and concession to the DOT Analysis, thus solving the awkward conundrum that time and tide forced upon the Commission. That Ligado was able to overcome the problems that the FCC found itself enmeshed in should be recognized as a heroic response to such regulatory conundrums and can serve as an example of regulators encouraging compromise and creative problem solving by impacted parties in such disputes. For such disputes are bound to happen again in other fields. To borrow from Shakespeare’s Hamlet, “There are more things in heaven and earth, regulators, than are dreamt of in your philosophy.”

Demand for Spectrum Continues to Grow

Even with the upcoming 28 and 24 GHz mm-wave auctions, wireless data demand continues to grow faster than the FCC is able to release spectrum for mobile use. As shown in the following Log plot, the slope of the blue allocated spectrum line is much more sedate than the rapidly rising orange line showing the number of PB/month of wireless data traffic in the US. The spectrum allocations double about every 8.2 years while the traffic is doubling in less than 1.3 years. The need for spectrum allocations to support 5G, telemedicine, IoTs, cord-cutting and the continuing growth in demand for existing services demands aggressive action to continuing to supply the vital needs of the modern citizenry.

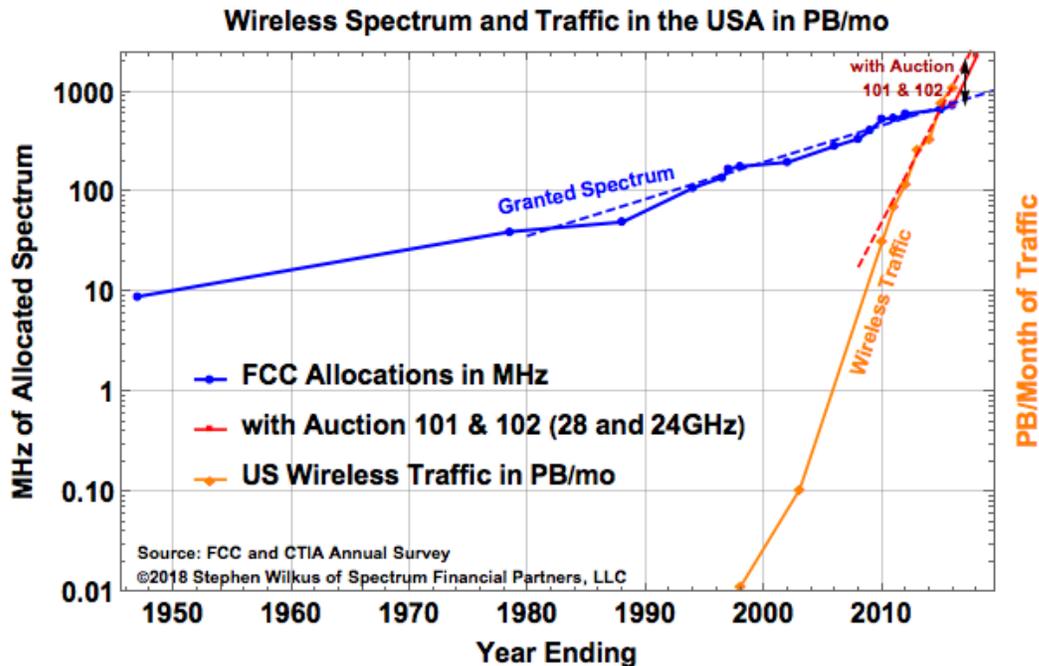


Figure 1 – Comparing the rising demand for wireless data traffic (shown in orange) and the slowly rising allocations of spectrum for mobile application, for the United States. This shows dotted lines for traffic growth doubling every 1.3 years and allocations doubling every 8.18 years. The addition of 1.950 GHz of allocated bandwidth in the upcoming auctions #101 and 102 are shown for 2018 as the rightmost point.

Increasing Diversity is Improving Robustness

The DOT and other evaluations of interference susceptibility have reasonably focused on L1 frequencies at 1575.42 MHz. However, there are currently at least 12 GPS satellites transmitting the additional L5 signal at

¹⁰ 47 CFR §15.19(a)(3).

1,176.45 MHz in a protected aeronautical band that provides diversity and protection for an increasing number of devices.¹¹ L2 is at 1227.60 MHz and the L4 signal at 1379.913 MHz is being studied for additional ionospheric correction. The advantages of this diversity are substantial though not considered in much of the analyses. Indeed, most of the consumer GPS devices integrated in smartphones include additional technologies for geolocation via data fusion of additional sensors such as WiFi, accelerometers, electronic compasses and in some cases even barometric pressure sensors that can give altitude and indoor location and orientation estimates that are far superior to what traditional GPS can provide. The author noticed that his car's navigation system showed the car's progress through a long tunnel with stop and go traffic, where the tunnel didn't just cause some interference it eliminated the satellite signals, and yet the additional sensors provided reasonable estimates of the car's position.

While these capabilities are not generally available to High Precision GPS units or in the installed base of aeronautical GPS systems, they point to the ways in which innovation is improving the robustness of geolocation facilities that have not been considered in these interference considerations. "Device performance is improving over time: The [Samsung] S6 exhibits better performance than the S5," observed Roberson and Associates in 2016.¹² Many filings to the FCC on these dockets appear to be "knee jerk" reactions to protecting L1 interference in all situations that increasingly no longer apply.



Current International Signal Plans

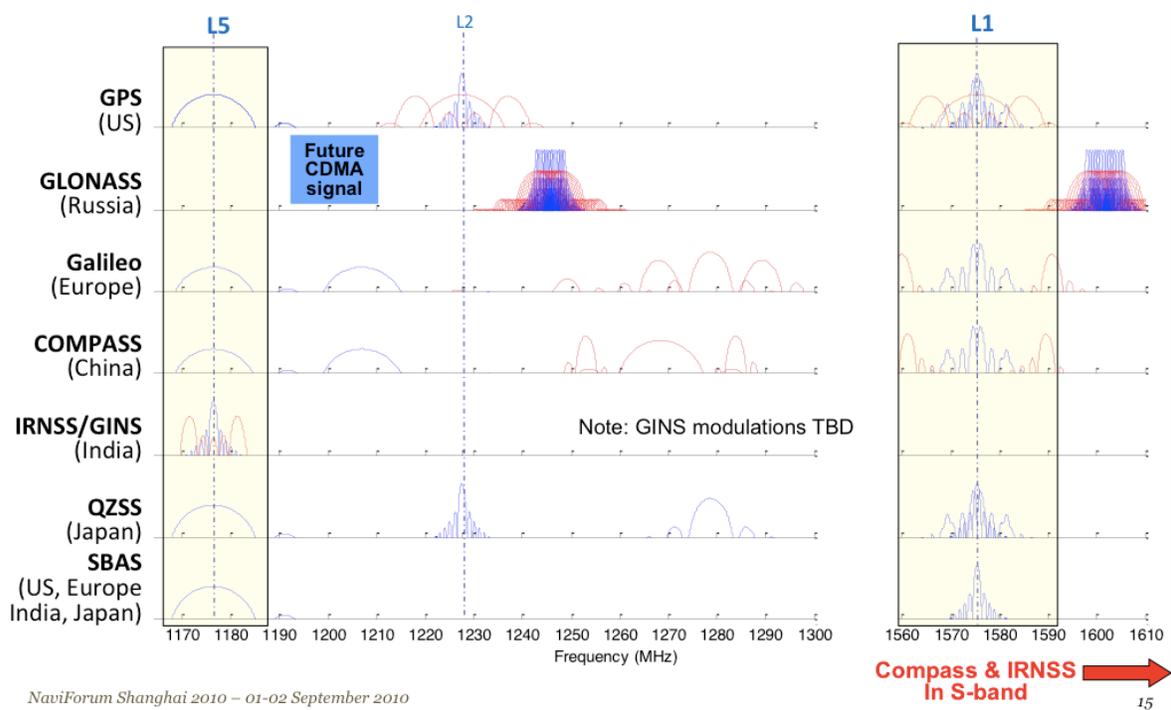


Figure 2 – International GNSS signals cover a multiplicity of frequencies that provide some redundancy for operations. Only the L1 signals are near Ligado's forward-link band (1526 to 1536 MHz), the other GNSS signals may work even if the L1 signal is degraded. Source: <https://www.gps.gov/multimedia/presentations/2010/09/shanghai/auerbach.ppt>

¹¹ According to GPS.GOV notice accessed June 30, 2018 at <https://www.gps.gov/systems/gps/modernization/civilsignals/>

¹² See letter to Ms. Dortch from Covington & Burling LLP in docket 11-109 & 12-340, June 10, 2016 section 9.2, page 41, available on-line at: <https://ecfsapi.fcc.gov/file/60002112686.pdf> last visited July 8, 2018.

Pursuant to Section 1.1206(b)(2) of the Commission's rules, an electronic copy of this letter is being filed for inclusion in each of the above-referenced dockets and files. If you have any questions about this filing, please contact me; I am at your service.

Respectfully Submitted,
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